How is VIIRS EDR Imagery Validated?

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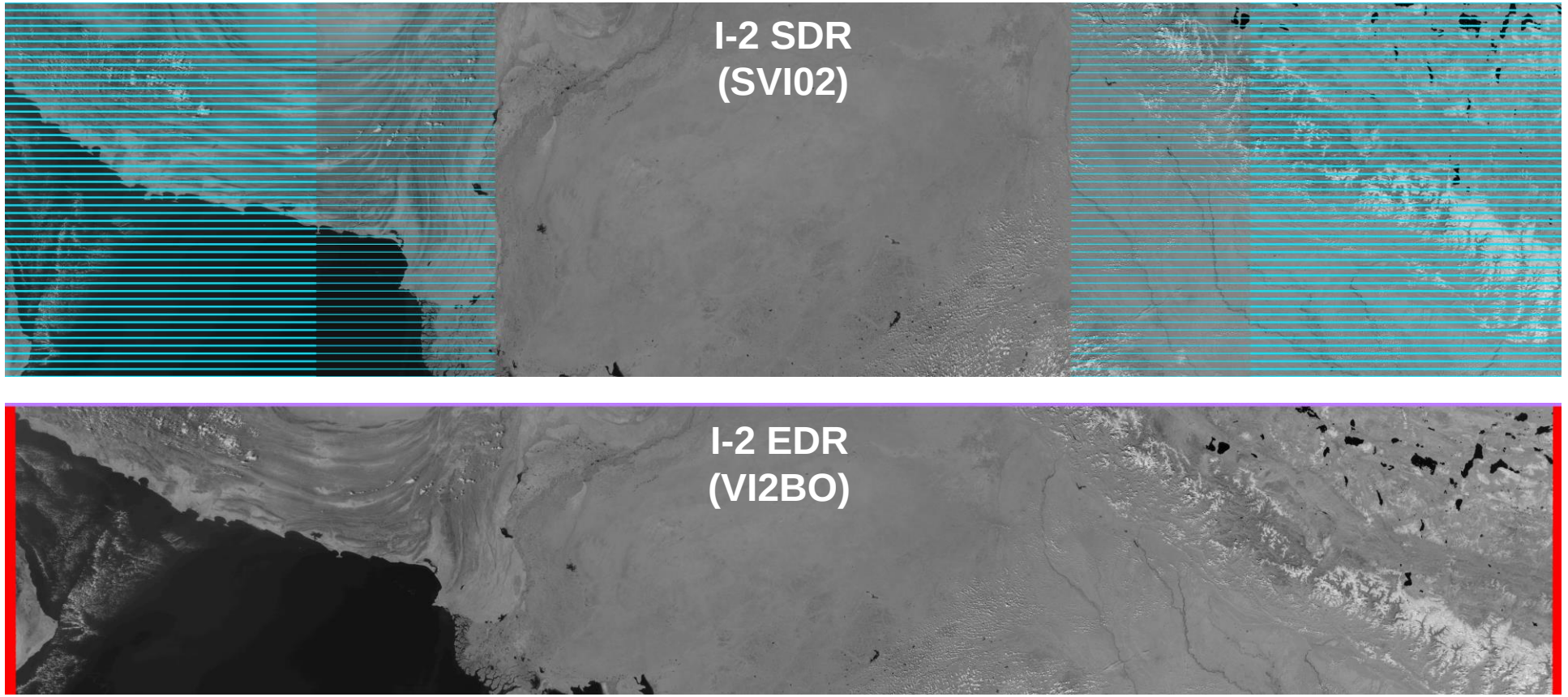
VIIRS EDR Imagery Basics

- The **Imagery EDR** is the projection (remapping) of SDRs onto a **Ground Track Mercator (GTM)** layout
  - For the non-DNB/NCC bands: the radiances or reflectances are the same
  - For the **DNB (SDR): the Near Constant Contrast (NCC) EDR** Imagery product has additional calculations involved
- **Advantages** of Imagery EDRs:
  - No bowtie-deletions
  - Overlapping pixels eliminated
- **Current EDR Imagery**:
  - 5 I-bands (all of them)
  - 6 of the 16 M-bands (default set, leaving 10 M-bands as SDRs only)
    - A VIIRS Imagery Team goal is to (eventually) have all 16 M bands as EDRs.

SDRs and EDRs: What's the difference?



Unmapped SDR and EDR granules from 08:14 UTC 24 October 2013

VIIRS Imagery Validation

- VIIRS EDR Imagery **Cal/Val Plan** finalized (Dec 2015)
  - For JPSS-1 and beyond
  - 2 new **KPP*** bands (I3 and DNB/NCC)
- *Remote Sensing* **article** (referenced at end of presentation)
  - Follows Cal/Val Plan for text
  - Examples from users of VIIRS Imagery
    - Alaska (in particular)
    - Non-Alaska uses (also important)
- NCC Imagery now in **AWIPS** feed (started Dec 2015)
  - VIIRS Imagery Team provided image scaling expertise
    - NCC Quick Guide
    - VISIT training module

*KPP = Key Performance Parameter

Required Imagery EDRs (8)

Imagery EDR Product	VIIRS Band	Wavelength (µm)	SDR spatial Resolution Nadir/Edge-of-Scan (km)
Daytime Visible	I1	0.60 – 0.68	0.4/0.8
Short Wave IR (SWIR)	I3 (new)	1.58 – 1.64	0.4/0.8
Mid-Wave IR (MWIR)	I4	3.55 – 3.93	0.4/0.8
Long-Wave IR (LWIR)	I5	10.5 – 12.4	0.4/0.8
LWIR	M14	8.4 – 8.7	0.8/1.6
LWIR	M15	10.263 – 11.263	0.8/1.6
LWIR	M16	11.538 – 12.488	0.8/1.6
NCC	DNB (new)	0.5 – 0.9	0.8/1.6

Other IDPS-generated Imagery EDRs (4)

Imagery EDR Product	VIIRS Band	Wavelength (µm)	Spatial Resolution Nadir/Edge-of-Scan (km)
Near Infrared (NIR)	I2	0.846 – 0.885	0.4/0.8
Visible	M1	0.402 – 0.422	0.8/1.6
Visible	M4	0.545 – 0.565	0.8/1.6
SWIR	M9	1.371 – 1.386	0.8/1.6

VIIRS Key Performance Parameter (KPP) statement

"VIIRS Imagery EDR at 0.64 µm (I1), 1.61 µm (I3), 3.74 µm (I4), 11.45 µm (I5), 8.55 µm (M14), 10.763 µm (M15), 12.03 µm (M16), and Near Constant Contrast EDR for latitudes greater than 60^0N in the Alaskan region"

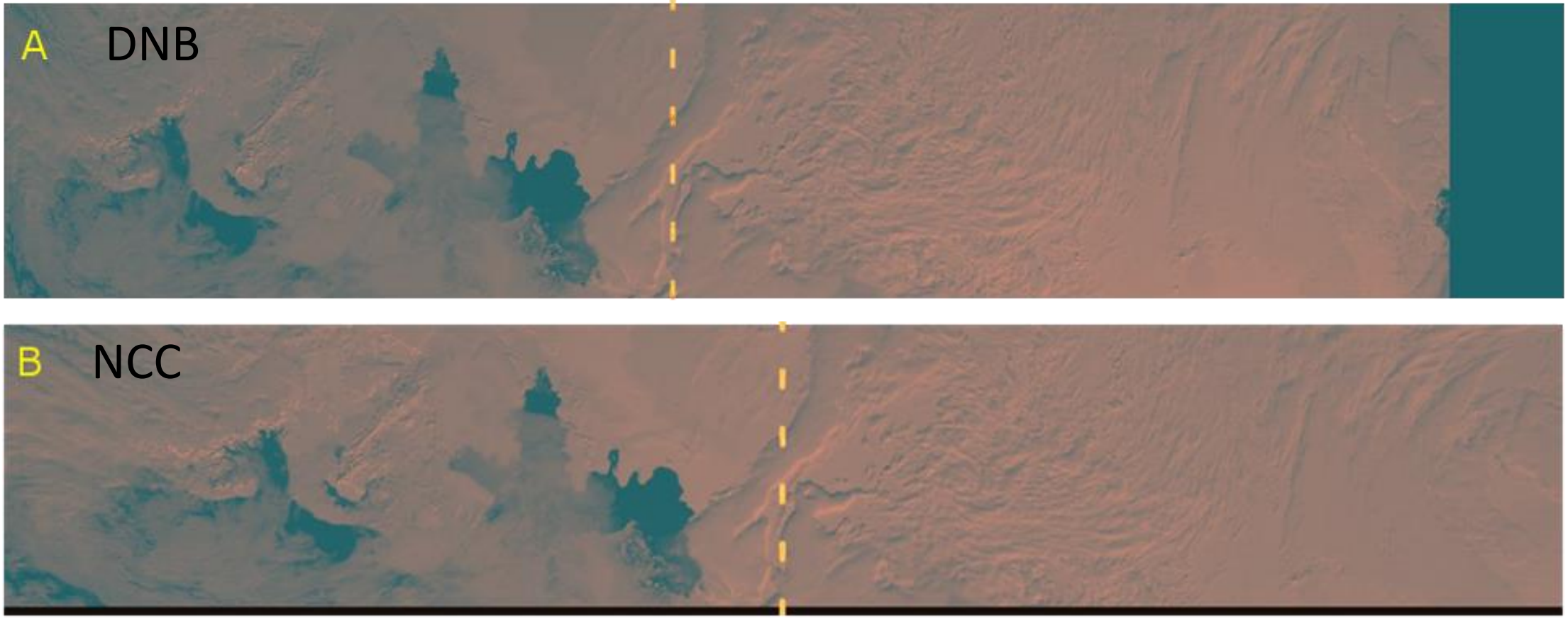
VIIRS by the numbers:

- **8 of 22 bands are KPPs**
- **16 of 22 bands are produced as EDRs (6 are SDRs only)**
- **22 SDRs**

Similarities and Differences between VIIRS SDRs vs. Imagery EDRs

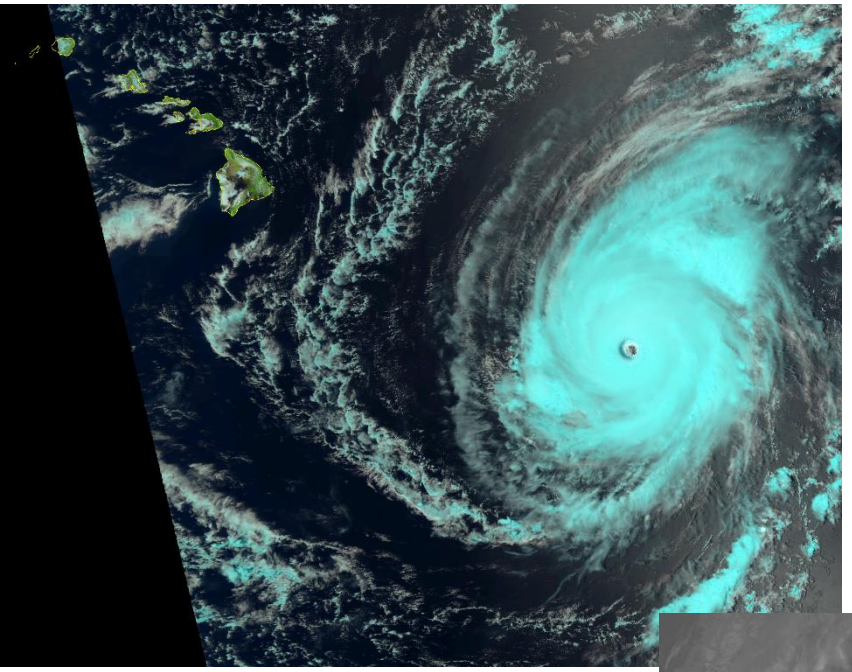
Characteristic	SDR	EDR
Solar reflective (visible) bands	Radiances and reflectances	Radiances and reflectances (**same as SDR**)
Infrared (thermal) bands	Radiances and brightness temperatures	Radiances and brightness temperatures (**same as SDR**)
Geo-spatial mapping	**Satellite projection** (with bowtie deletions and overlapping pixels)	**Ground Track Mercator (GTM)** projection (rectangular grid, no pixel deletions or pixel overlap)
Day/Night Band (DNB) imagery	**DNB radiances** (may vary by up to 7 orders of magnitude, depending on lunar and/or solar illumination)	**NCC pseudo-albedos** (may vary by up to 3 orders of magnitude, to display features under conditions ranging from no moon to full solar illumination, as well as artificial lights)

Simulation of increased aggregation at edge of swath and extended granule for JPSS-1 DNB



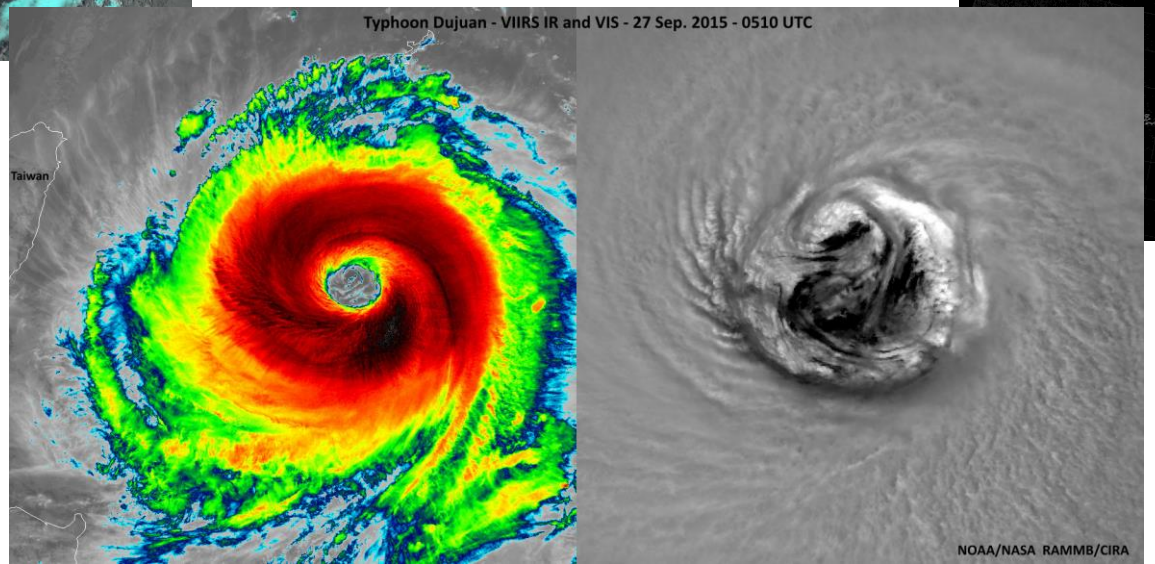
(a) DNB from S-NPP used to display how DNB will look from JPSS-1, with the blue area on the right filled with extended scene imagery (currently missing in this simulation); (b) The DNB remapped into the GTM mapping used for NCC, showing that the NCC shifts the DNB imagery to the right, placing nadir at the center and ignoring the extended scene data on the right. In each image, the dashed line shows the approximate location of nadir.

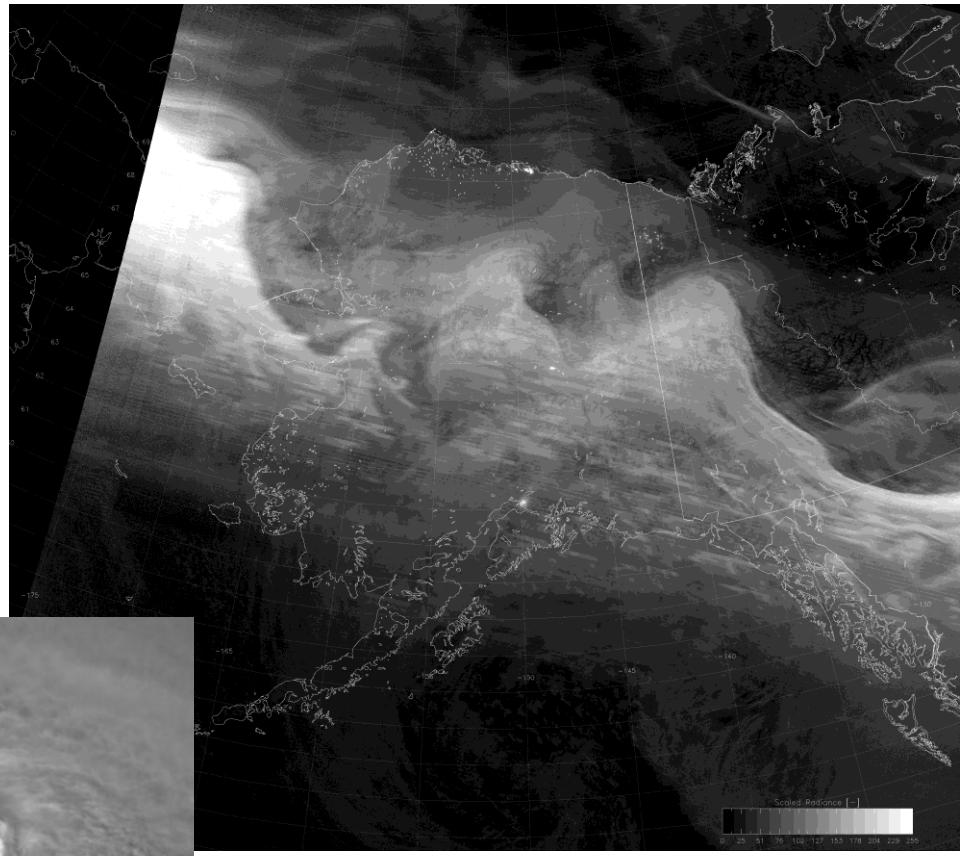
StAR JPSS Image(s) of the Month



False-color (Natural-color) image of Hurricane Ignacio as a Category 4 hurricane approaching Hawaii seen by VIIRS with 375 m resolution on 29 August 2015

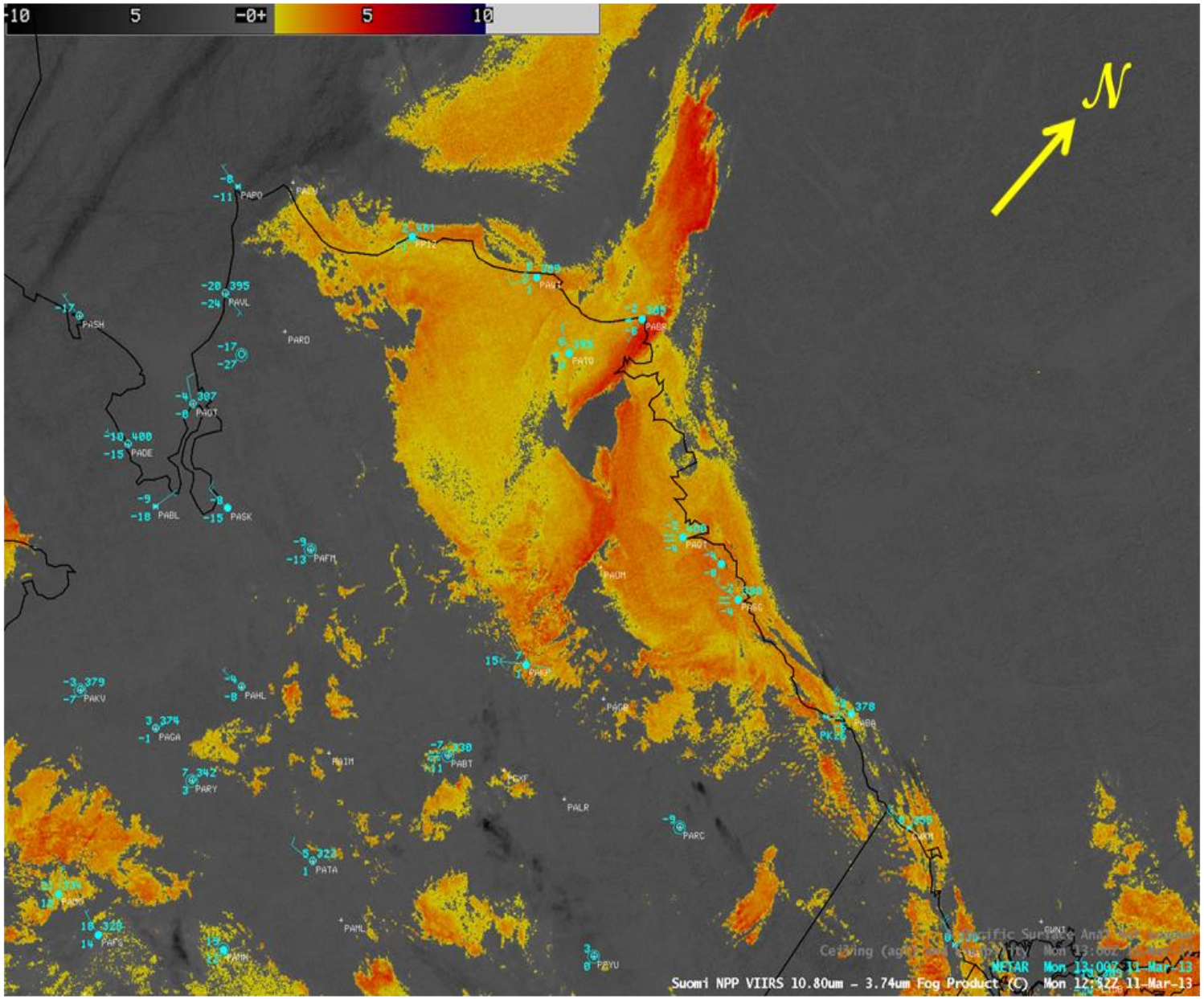
Typhoon Dujuan near its peak intensity of 125 kt on 27 September 2015





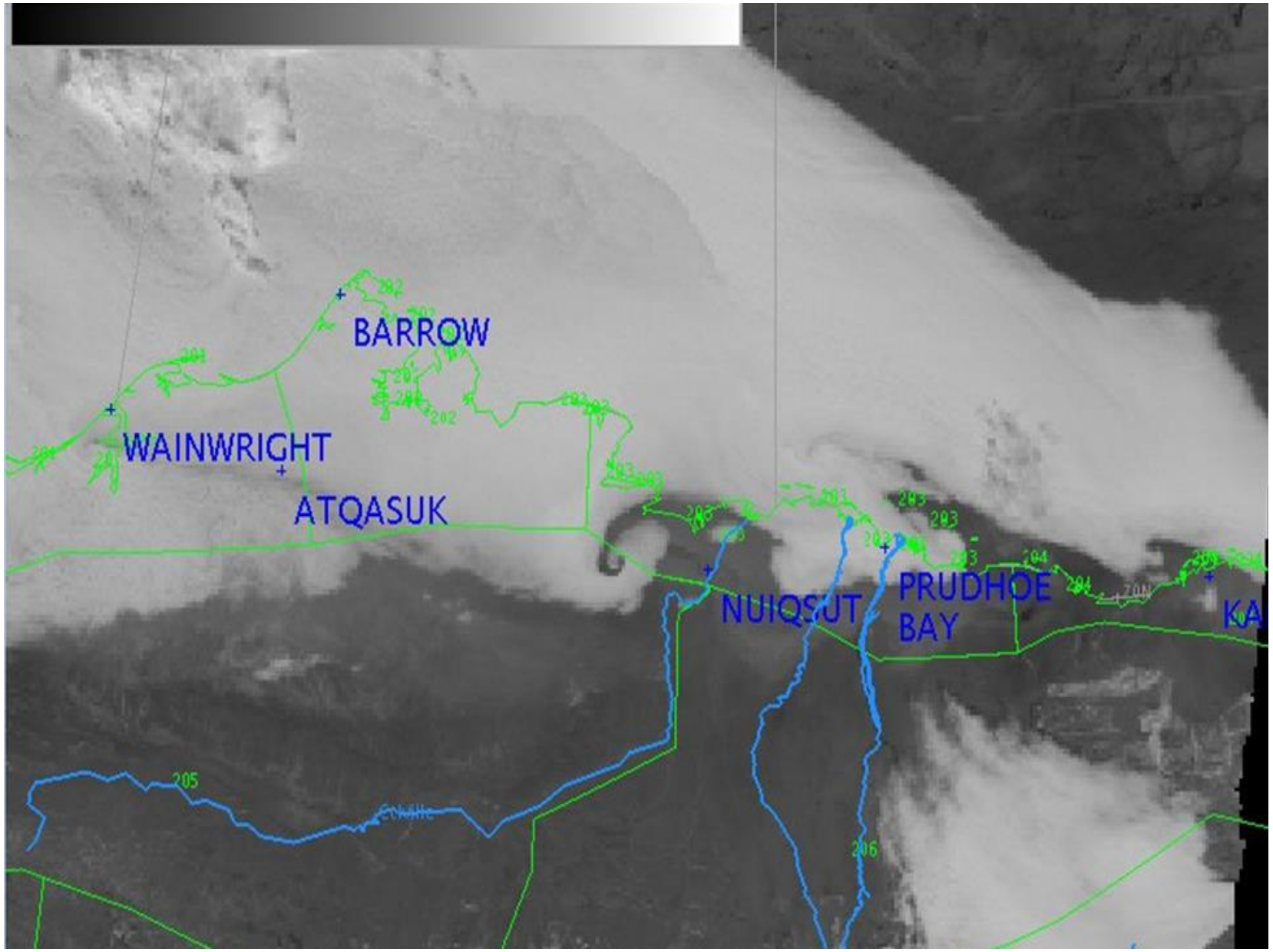
DNB of Aurora over Alaska and Canada

VIIRS Imagery Examples from Alaska users



Color-enhanced 11-3.9 µm BTD, low cloud/fog in AWIPS, North Slope

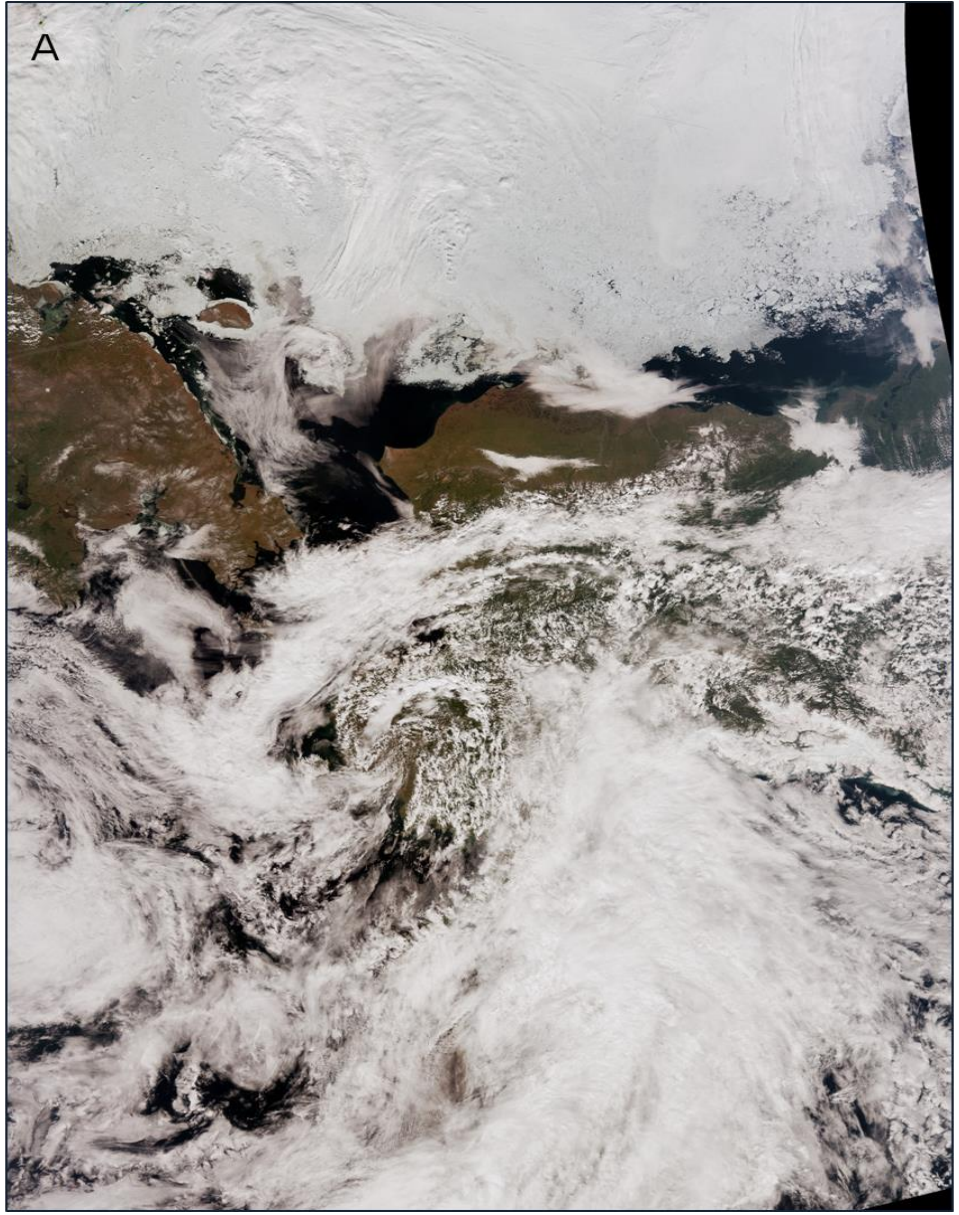
Color-enhanced 11-3.9 µm BTD for 11 March 2013 at 1252 UTC, along with METAR observations at 1300 UTC. The oranges indicate areas of low cloud/fog, where the light grays indicate higher clouds and the black indicates thin cirrus.

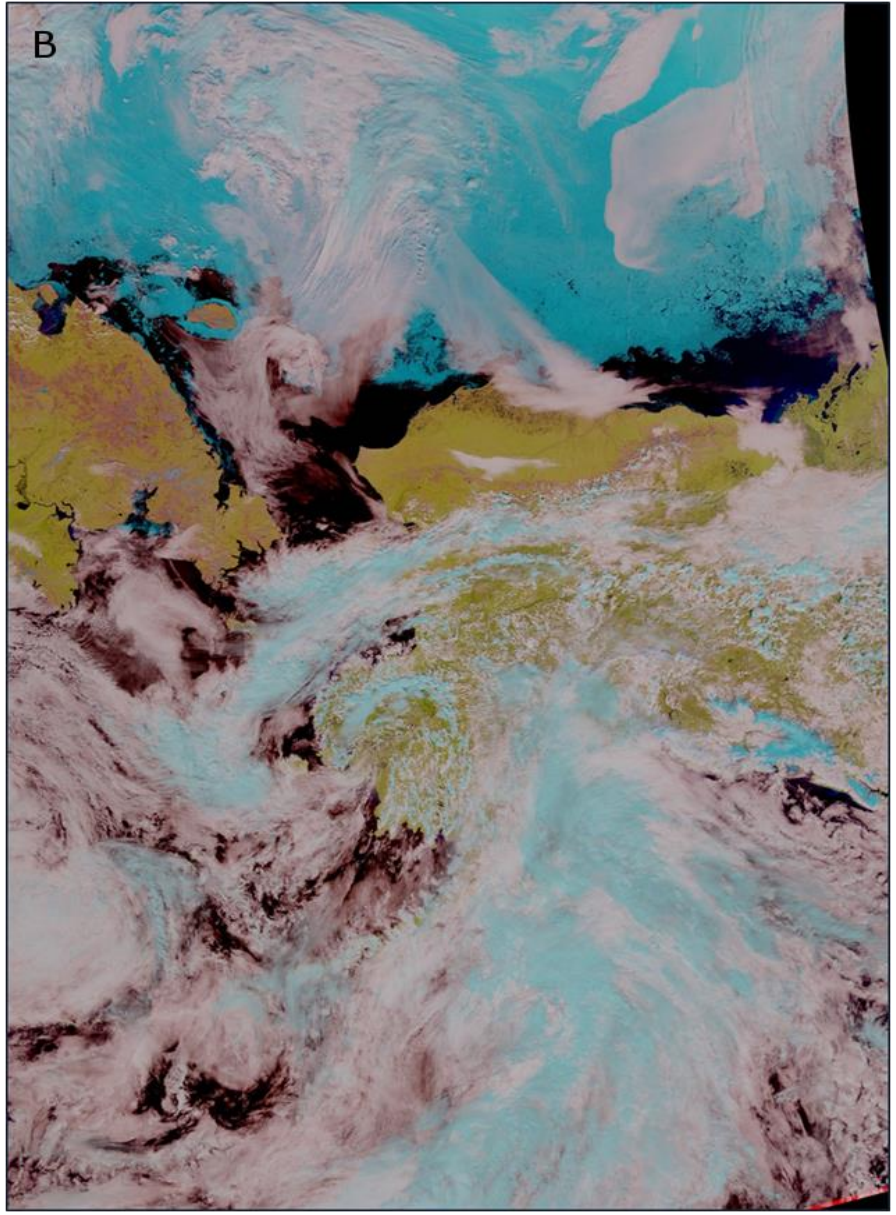


VIIRS I3 (1.61 µm), low clouds and fog, North Slope

VIIRS I3 (1.61 µm) band along the North Slope on 26 April 2015 at 0004 UTC. The white colors indicate areas of low clouds and fog, where the darker gray indicates the clear conditions. The light blue lines are the rivers with the green lines indicating the boundaries for the zone forecast areas.

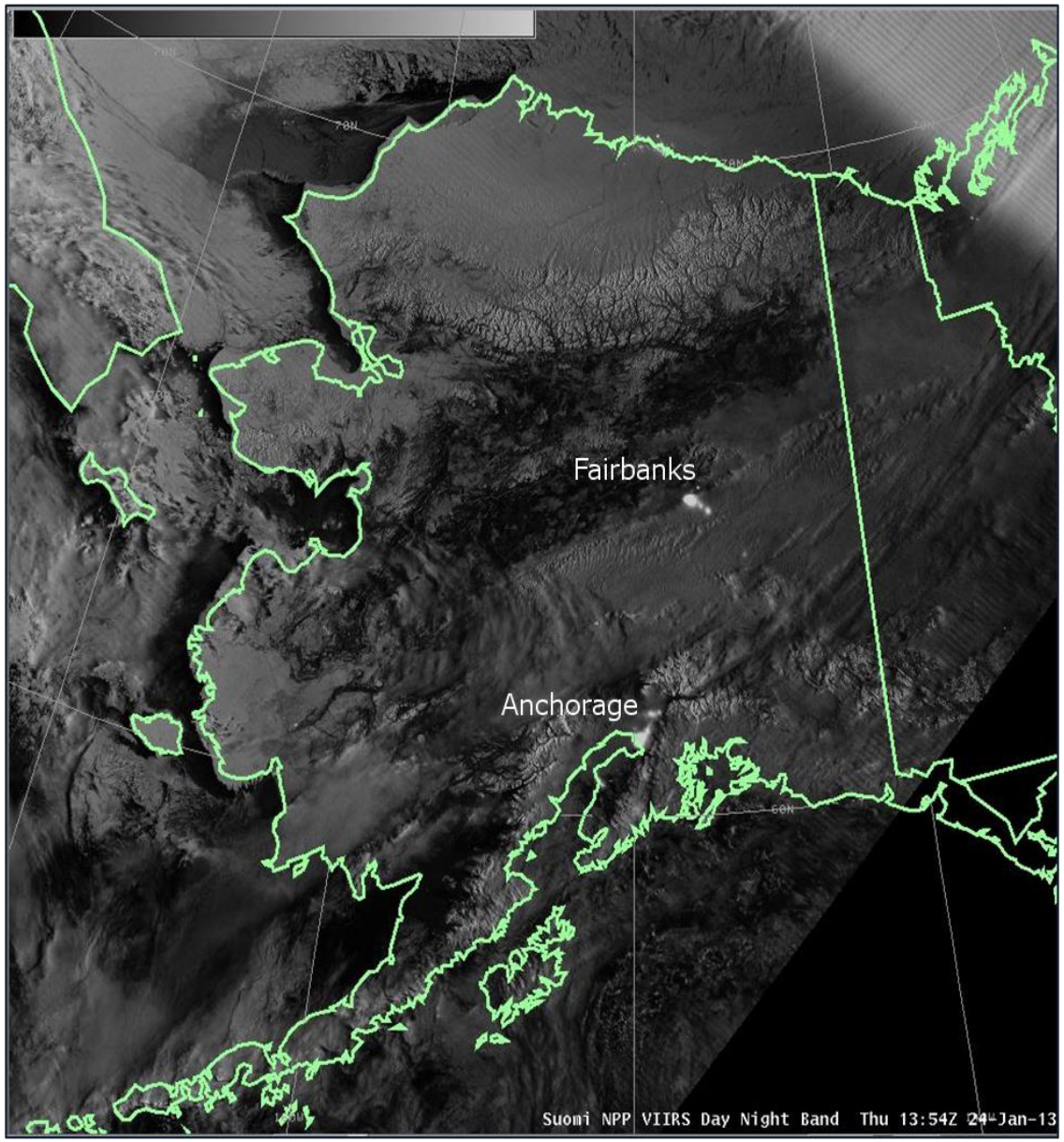
True-Color RGB





Natural-Color RGB

VIIRS True-color RGB combining the I1 (0.64 µm) band with the M3 (0.49 µm) and M4 (0.55 µm) bands, and (b) VIIRS natural-color RGB composite image combining the VIIRS I3 (1.61 µm), I2 (0.86 µm), and I1 bands, both from 9 July 2015 at 2302 UTC.

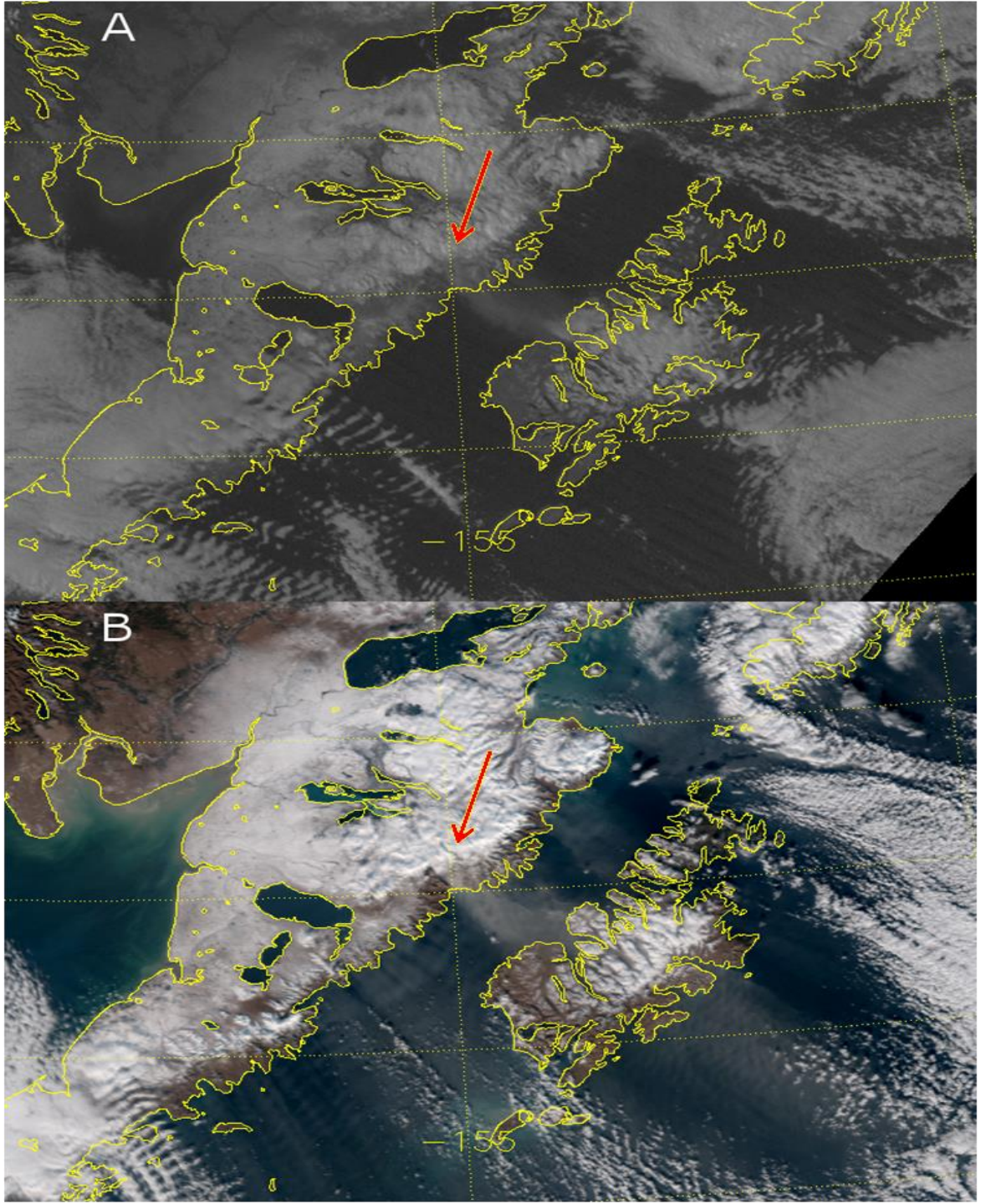


VIIRS DNB imagery in AWIPS

Example of VIIRS DNB imagery for 24 January 2013 as displayed on an NWS AWIPS workstation. An adjustable gray-scale appropriate to the lunar (or solar) illumination at the time is used to enhance the DNB radiances to best reveal cloud and surface features.

DNB

True-color



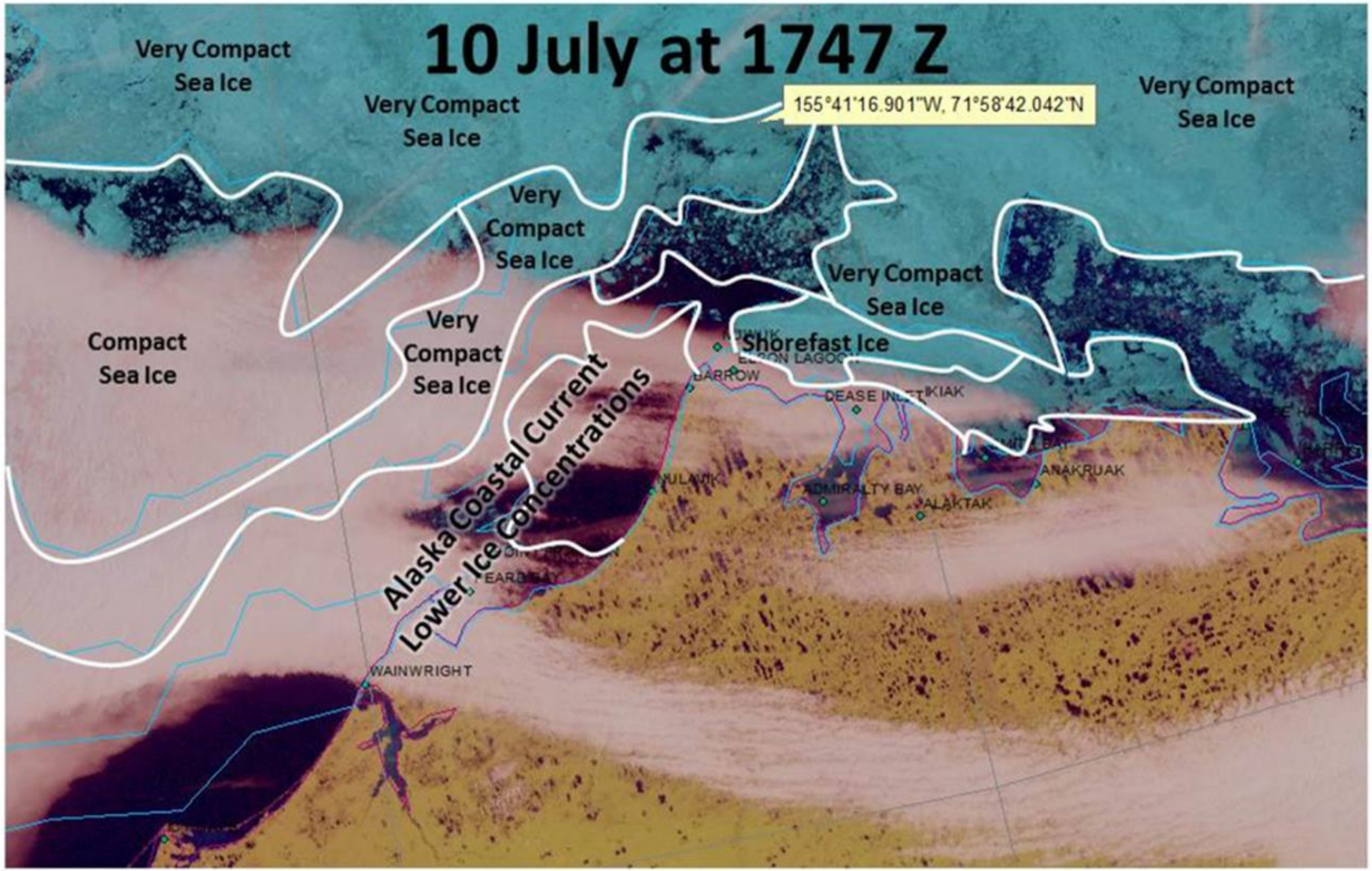
Re-suspended ash, 1912 Novarupta eruption, in 2012

(a) VIIRS DNB image showing re-suspended ash from the 1912 Novarupta eruption (1411 UTC 30 October 2012) (b) VIIRS true-color image of the ash plume (2223 UTC 30 October 2012). In each image, the location of Novarupta is indicated by a red arrow. The ash plume extends from the volcano to the southeast across the Shelikof Strait and Kodiak Island.

Alaska Social Media reports, Aggie Creek fire

Two social media reports from 6 July 2015 about the Aggie Creek fire located northwest of Fairbanks: (top) as seen from the NWS Fairbanks office on the University of Fairbanks campus; (bottom) the VIIRS False-Color satellite imagery at 2312 UTC and the radar reflectivity image from the Pedro Dome radar are shown side by side.

Suomi NPP False Color Satellite Image



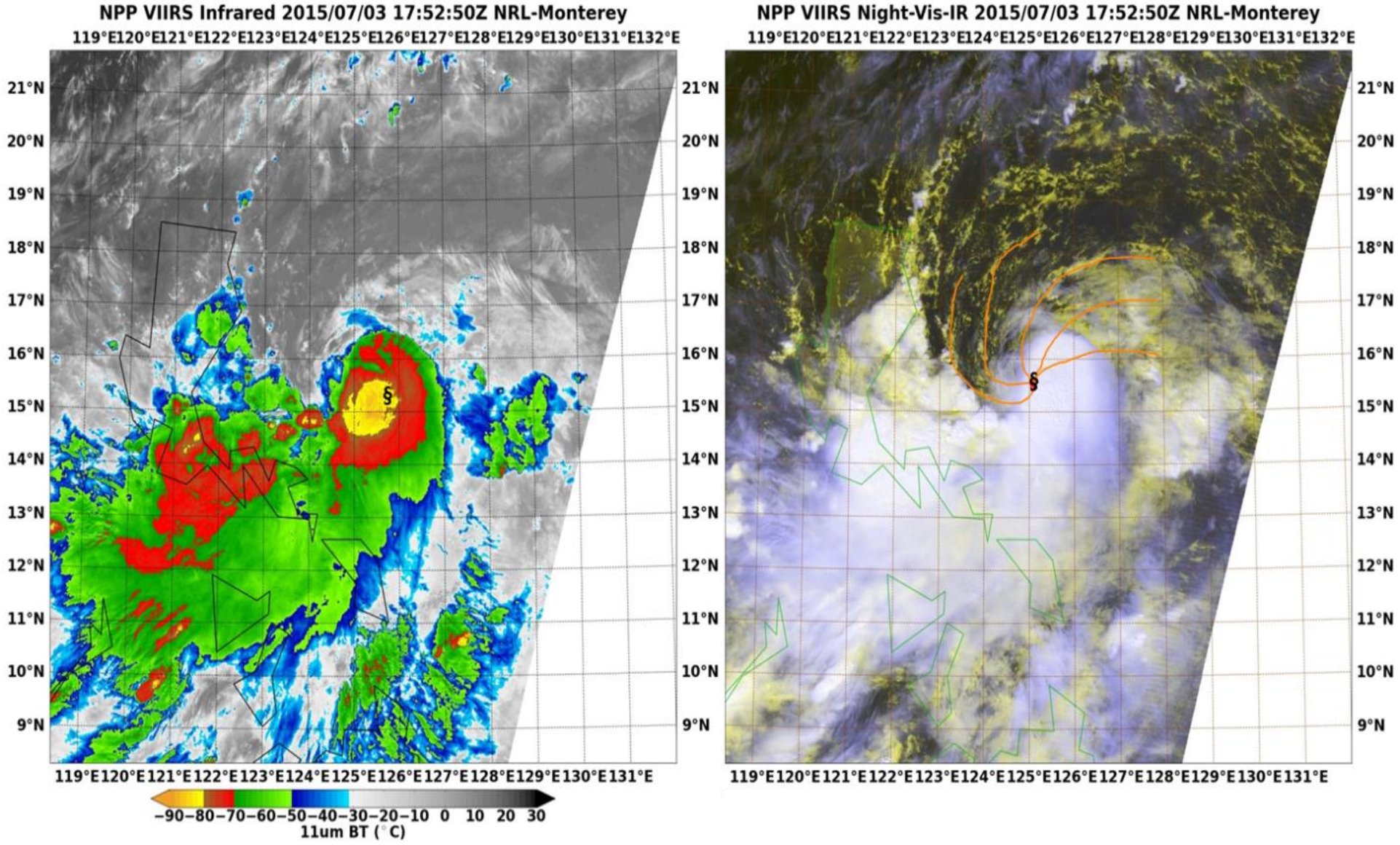
Annotated VIIRS RGB composite image from the NWS Ice Program in Anchorage AK, including the position of the boat stranded in the ice. (Image courtesy of Mary-Beth Schreck.)

VIIRS Imagery Examples from non-Alaska users

TC Linfa re-centering

I5 (11.45 µm)

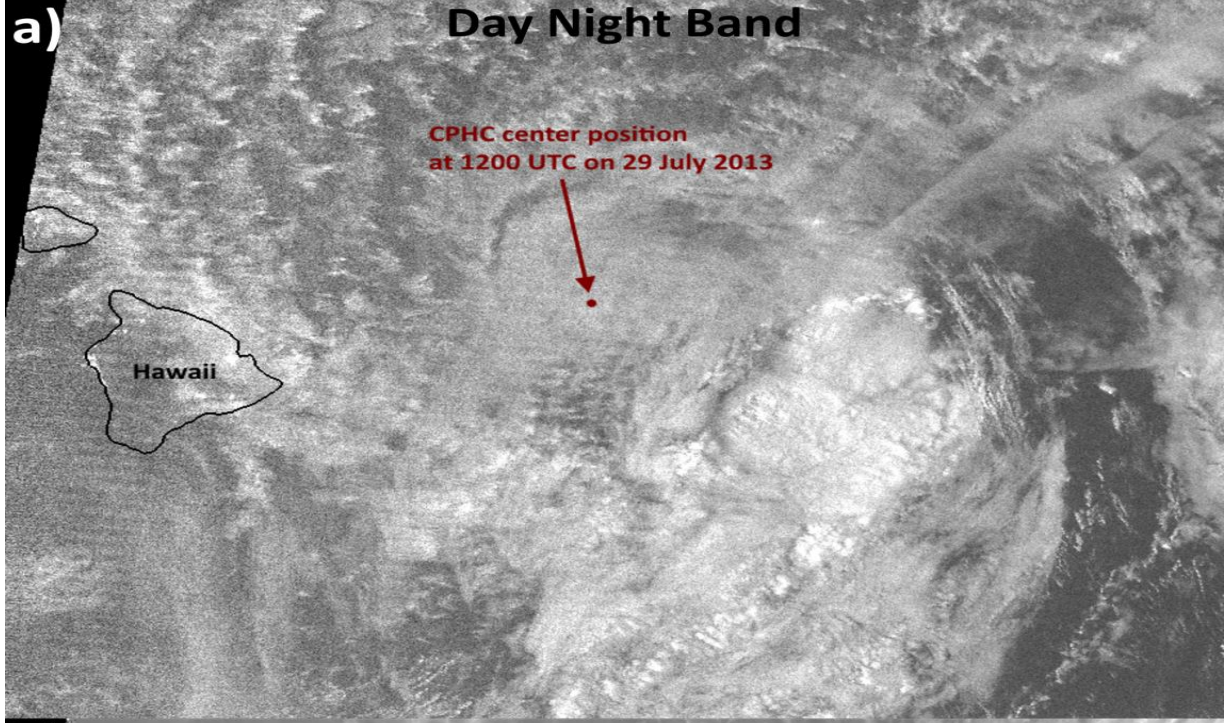
RGB composite (using DNB)

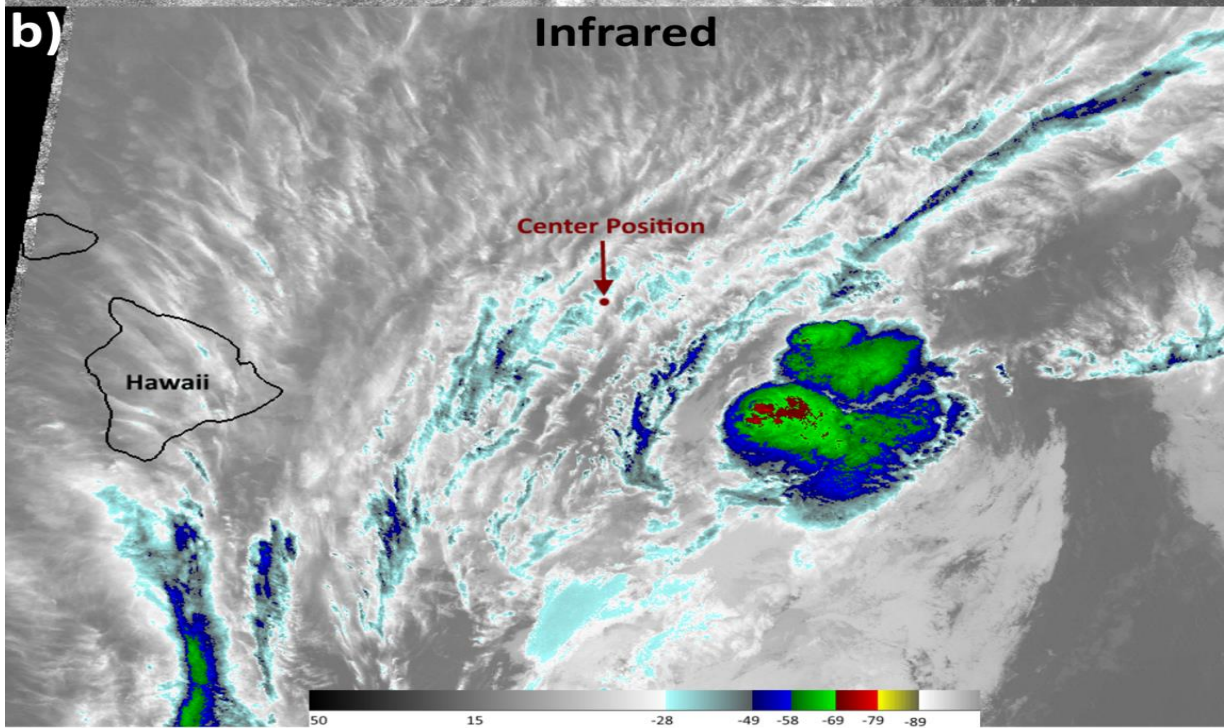


VIIRS (a) I5 (11.45 µm) band brightness temperature and (b) RGB composite imagery of Typhoon Linfa from 3 July 2015 at 1752 UTC. The RGB composite is composed of the DNB in the red and green bands and inverted I5 brightness temperatures in the blue. The RGB composite was used by JTWC analysts to correctly determine the center of the typhoon by tracing the low-altitude cloud lines (orange) to the center of circulation.

DNB

IR





TC Flossie re-centering

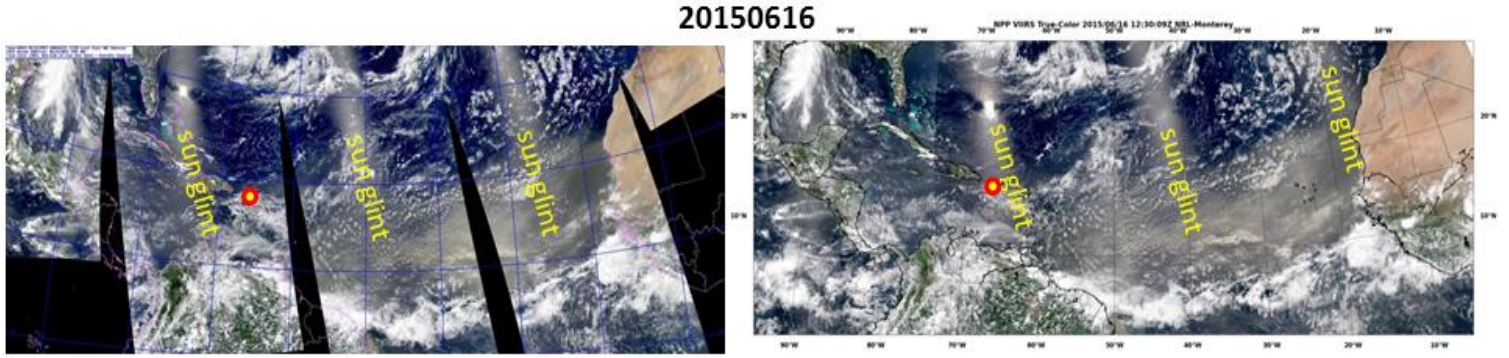
VIIRS (a) DNB and (b) I5 (11.45 µm) image showing Tropical Storm Flossie east of Hawaii on 29 July 2013 at 1103 UTC. The analyzed position by the Central Pacific Hurricane Center of the center of the storm at 1200 UTC is denoted by a maroon dot in both images. The units of brightness temperature in (b) are degrees C. Striping in the DNB becomes more apparent as the signal level decreases under lowlight illumination.

Saharan Air Layer (SAL)

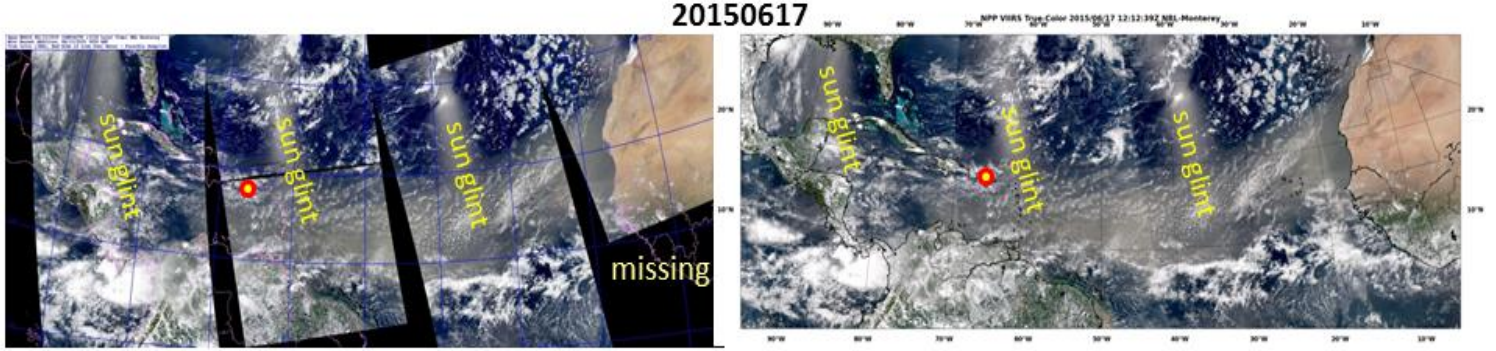
Aqua MODIS True Color

VIIRS True Color

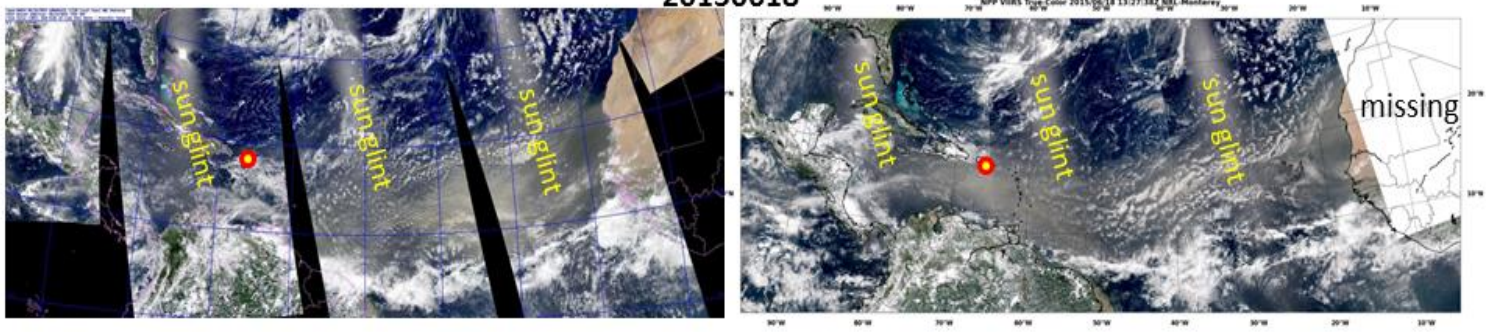
20150616



20150617



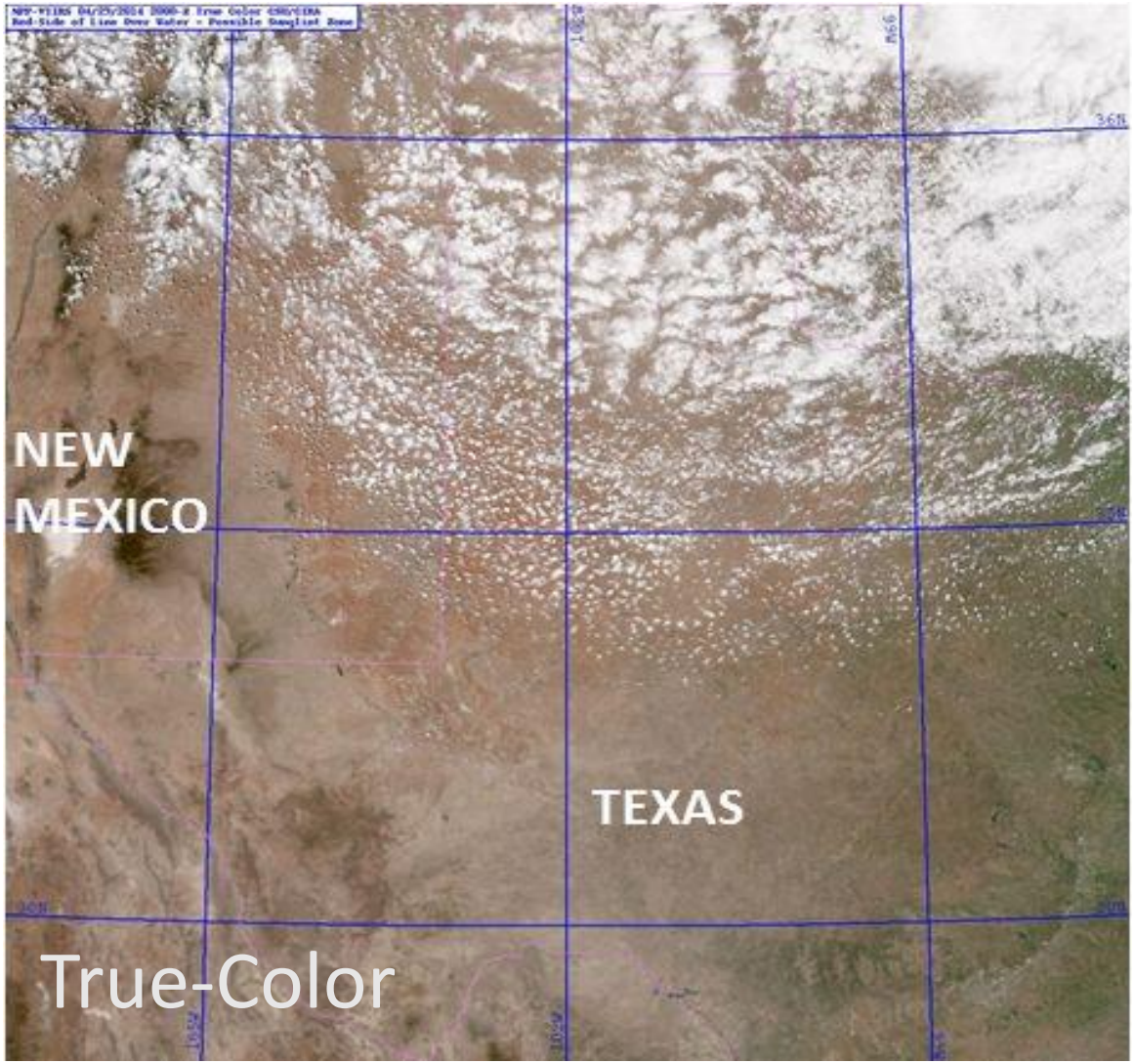
20150618

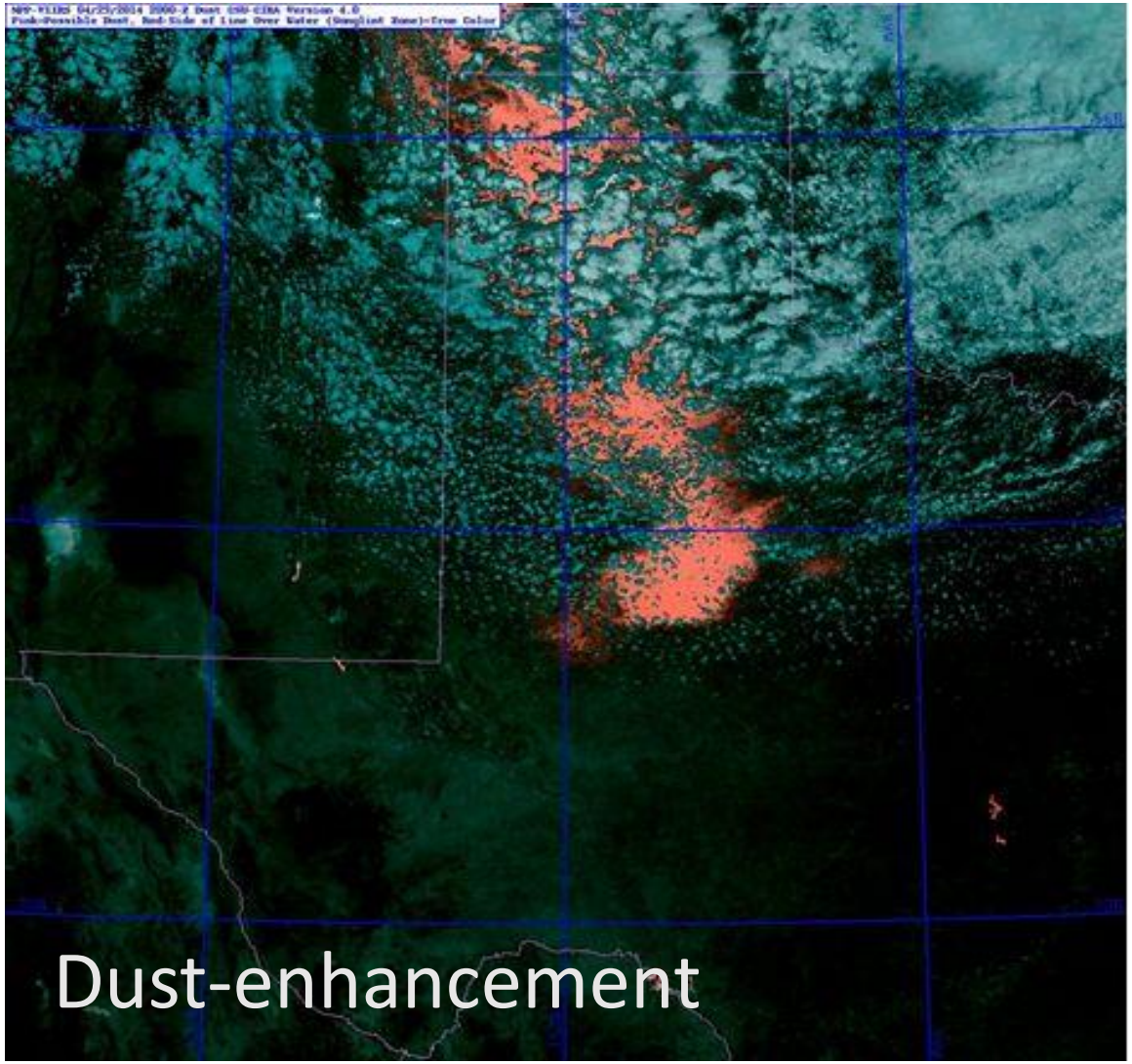


MODIS

VIIRS

Comparing Aqua MODIS (left panels) vs. S-NPP VIIRS (right panels) true-color image products while monitoring a SAL event across the north tropical Atlantic basin during 16-18 June 2015. The increased swath within VIIRS reduces the "guesswork" in tracking dust. Sun glint regions indicate enhanced levels of reflection from the ocean surface.





(left) VIIRS true-color imagery for the Texas Panhandle at 2000 UTC on 29 April 2014 with no obvious signs of dust in the scene, (right) VIIRS dust-enhancement imagery at the same time, highlighting the blowing dust in pink below the overlying clouds in cyan.

Summary/Conclusions

- **EDR Imagery Cal/Val Plan** (for JPSS-1 and Beyond) completed
- **Article** on VIIRS Imagery in *Remote Sensing* cal/val special issue published
  - Hillger, D.W., T. Kopp, C. Seaman, S.D. Miller, D.T. Lindsey, E. Stevens, J. Solbrig, W. Straka III, M. Kreller, A. Kuciauskas, and A. Terborg, 2015: User Validation of VIIRS Satellite Imagery. *Remote Sensing*, **8**:11, doi: 10.3390/rs8010011
- Continuing/routine Imagery validation for S-NPP, involving VIIRS end users (particularly those in **Alaska**)
  - As operations/ground systems change
  - Make sure imagery remains at consistent high quality
- **JPSS-1** to be launched in **FY17**
- **JPSS-2 and Beyond** (JPSS-3 and JPSS-4)
- And finally! (last slide)

VIIRS/DNB on postage stamps (from The Gambia)!